

Wilcox Oil Company Superfund Site

Work Plan for Investigation of Lead Contamination at the Ethyl Blending and Lead Sweetening Areas

Bristow, Creek County, Oklahoma

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1. Introduction

1.1. Objective

The presence of lead contaminated soil is suspected at two areas of concern (AOCs) at the Wilcox Oil Superfund Site. The objective of this investigation is to identify the horizontal extent of lead contamination in the upper two feet of soil near these two suspected sources, and identify areas where lead concentrations in soil are greater than a screening level of 200 milligrams per kilogram (mg/kg). The site is currently in the Remedial Investigation and Feasibility Study (RI/FS) phase of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process and the results of this investigation will be used to support characterization, risk assessment and remedial action decisions. The focus of the activities described in this Work Plan is the investigation of lead contamination in soil. Other concurrent RI/FS activities during this first mobilization are being conducted by EPA Region 6 that address other media and chemical constituents at other AOCs.

1.2. Existing Conditions

Wilcox Oil Company is an inactive and abandoned oil refinery located in Creek County, Oklahoma (Figure 1) in the northeast section of the town of Bristow, Oklahoma. The site encompasses approximately 140 to 150 acres and includes five areas: the Wilcox Process Area, the Loraine Process Area, the Loading Dock Area, the North Tank Farm, and the East Tank Farm. Several preliminary investigations have occurred at the site beginning in 1994. In 2015, Lockheed Martin assisted the Environmental Protection Agency/ Environmental Response Team (EPA/ERT) and EPA Region 6 to perform a direct sensing investigation to qualitatively address the nature and extent of contamination at several sites using direct sensing tools including the rapid optical screening tool (ROST) and X-Ray fluorescence (XRF). Details of the site history and previous investigations can be found in the reports from these investigations (Lockheed Martin, 2016).

Within the Wilcox Process Area, the two areas containing lead as the contaminant of potential concern (COC) in soil are shown on Figure 1 and include:

- Lead Sweetening Area (LSA)
- Ethyl Blending Area (EBA)

The detailed sampling designs for each of these areas are presented in Sections 2 and 3 of this Work Plan, respectively, and provide a discussion of the suspected sources and existing conditions.

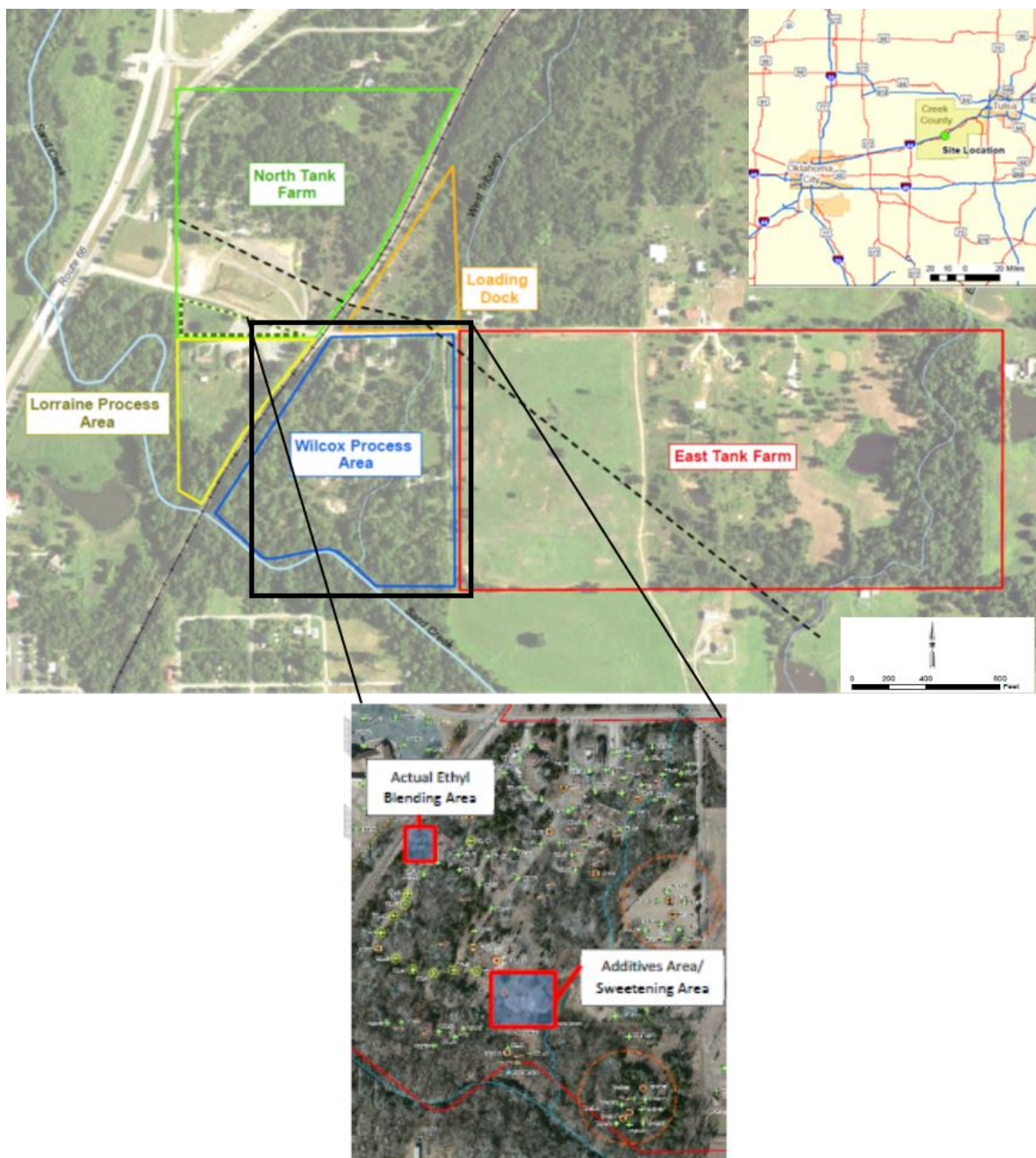
1.3. General Strategy

The investigation of lead contaminated soil will be performed using the principles of Incremental Composite Sampling (ICS) and near real-time X-ray fluorescence (XRF) analysis to delineate areas where surface and subsurface soils contain concentrations of lead in excess of 200 mg/kg. The approach will include evaluating:

- Concentrations at suspected source areas and hotspots
- Concentration trends away from known and suspected source areas (transects)

- Concentrations of Decision Units that represent areas above and below the 200 mg/kg screening level.

Figure 1: Wilcox Oil Superfund Site Location and Features



(from EA Draft Sampling and Analysis Plan for the Wilcox Oil Company Superfund Site Remedial Investigation/Feasibility Study, April 2016, and SERAS Trip Report, 2016)

1.3.1. Sample Collection Methods

Soil from two depths will be evaluated. Surface soils, defined as samples from the ground surface to 6 inches (0 to 0.5 feet) will be collected to support ecological risk screening, and samples from 6 to 24 inches (0.5 to 2 feet) will be collected to support human health risk screening.

Samples will be collected using a soil sampling probe approximately 1 inch in diameter and 24 inches long driven by hand (slam bar/slide hammer), hand held driver (pneumatic or electric hammer drill), and/or a small GeoProbe rig. Screening level surface samples will be collected using a CRREL Multi Increment Sampling Tool (CMIST), sometimes referred to as a Pogo Sampler. The CMIST can be used to rapidly obtain samples from the upper 3 inches of soil and comes in a range of different diameter sample cups to change the mass of soil collected. The sampling devices are shown in Figure 2.

Soil samples will be collected in clean, sealable plastic bags and labeled with the site and sample identification number. Samples will be processed and analyzed at the field lab. After analysis samples will be archived and available for additional analysis, such as disposal classification via toxicity characteristic leaching procedure (TCLP), if needed.

1.3.2. Overview of Incremental Composite Samples and X-Ray Fluorescence Analysis

Contaminant distribution in soils is heterogeneous and discrete sample methods cannot account for the variability in contaminant concentration over short scales. Additionally, discrete soils samples are representative of a single point and do not define the concentration of a specific area. The standard methods used to process soil samples, and select the small volume (1 to 2 grams) for fixed-lab analysis results in additional uncertainty and bias in results. The sum of the sampling, processing and analytical uncertainties may result in a concentration that is not representative of the actual conditions, and could lead to a decision error.

The Incremental-Composite Sampling (ICS) is a soil sampling protocol that reduces data variability and reasonably assures all contamination present within a defined area or volume of soil is adequately represented in samples that are collected and analyzed. In ICS, many equal mass “increments” of soil collected from multiple locations within a defined area or volume are combined into a single “field” sample that represents the area or volume of soil of interest. Combining increments may appear to be similar to conventional compositing of samples. However, ICS improves on the composite concept by establishing a Decision Unit (DU) that is represented by a single sample designed to contain all constituents in the same proportion as they are present in the DU (i.e., the sample is representative of a specific area – the DU). The DU represents the smallest volume of soil about which a project level decision is to be made (exposure risk, remedial action), and in some cases a DU comprise smaller units known as sampling units (SUs). By defining a DU the ICS sample result represents the mean concentration within the area, which cannot be done with discrete samples. The Interstate Technology and Regulatory Council (ITRC) has developed a guidance document that provides an extensive discussion on the theory and application of incremental sampling methodology (ITRC, 2013).

ICS requires specialized procedures both in the field and in the laboratory (preparation and analysis). The systematic planning process is an integral part of ICS that is required to develop a comprehensive sampling and analysis strategy. Planning includes defining the size and depth of the DU (volume represented by the sample), the number of increments of soil to be collected within the DU, the volume of each increment, and the processing required ensuring the sample is representative of the decision to be made.

X-ray Fluorescence (XRF) is a nondestructive analytical method used to measure the concentration of many different metals, including lead, in soil and other media, and is complementary technology to ICS is the use of rapid analysis for real time decision making. Rapid analysis allows adaptation of the sampling strategy to reflect the site specific conditions. The instrument can be deployed either hand-held for portable direct analysis of soils in the field, or stand-supported to analyze prepared samples in a more controlled environment such as a field laboratory. In the field laboratory, measurement of lead in prepared samples takes between 2 to 10 minutes, depending on the number of repeat measurements required, and has a detection limit well below the decision criteria for this site.

Details of the sampling, processing and analytical method are provided in the Quality Assurance Project Plan (QAPP) in Section 4 of this Work Plan.

1.3.3. Wet and Indurated Samples

The Quality Assurance Project Plan (QAPP) in Section 4 of this Work Plan provides a detailed description of the soil sample processing and analysis methods. During sampling, the sample collection team will qualitatively evaluate the soils for moisture and cohesiveness (induration). Saturated soil and/or soils containing large amounts of rock fragments can interfere with XRF readings. Saturated or very wet soils may require drying prior to analysis, which is not anticipated to be performed at the site, and may result in a modification to the sampling and analysis procedures. If soils are extremely hard or contain abundant rock fragments that limits the amount of sample collected, the procedures may be modified in the field. Modification may include collecting additional volume at increment locations, collecting additional increments, or abandoning the locations.

1.3.4. General Sample Design

For this work, two scales of incremental composite samples will be applied, one for determining the true concentration of some specified volume of soil (a DU), and another for determining a concentration trend across large areas of soil for the purpose of locating cleanup boundaries.

The ICS design that will be used to assess concentration trends and locate the 200-ppm Pb cleanup boundary near surface and at depth will be based on “sampling units” (SUs). An SU is a volume of soil that is typically much smaller than a DU for which the true concentration can be estimated with a lower degree of confidence than that used for DUs. DUs and SUs differ as to their purpose: DUs concentrations are typically compared to a cleanup, compliance or risk threshold, or are used as the exposure point concentration (EPC) as input to a quantitative risk assessment. The spatial pattern of contamination within a DU is of less importance than the DU’s true concentration. SUs are used specifically to gather and preserve information about spatial patterns of contamination, either within pre-defined DUs, or before DUs have been defined.

SUs are sampled using fewer increments than typically used for DUs, because knowing the exact concentration is less important than identifying soil areas/volumes having “higher” vs. “lower” concentrations. SUs can be used within DUs for the purpose of targeting areas for cleanup if the DU concentration should exceed a cleanup threshold. SUs can also be used to reduce uncertainty in a CSM by providing an understanding of the size of source areas and any concentration trends surrounding them. A more complete CSM allows the project team to design DUs of appropriate size and locate DUs such that there is little chance that a single DU will overlap areas having markedly different concentrations.

SUs cover small areas on the order of a few square feet. The number of increments must be no less than five, but the exact number depends on the heterogeneity of the soil. SUs are used rather than discrete samples because the high variability (i.e., “noise”) observed with discrete samples can either mask a true spatial trend, or falsely indicate a trend where none actually exists. The purpose of SU composite sampling is to suppress the misleading effects of short-scale soil heterogeneity (i.e., reduce the “noise”) so that a true trend signal can be observed. Quality assurance (QA) practices are used early in the project to establish the SU configuration (area of soil covered and the number of increments) that balances sufficient noise suppression against the level of effort involved with SU sample collection, processing and analysis.

Both SUs and DUs will be used to investigate the lead-contaminated areas of the Wilcox Oil Superfund Site. SUs will be used extensively to map the size and extent of the “sweetening area” identified by ERT. The exact configuration will be determined by the initial use of “SU couplets,” which are described in greater detail in the QAPP. The starting SU configuration will be nine increments arranged in three rows of three over a 2 x 2 sq.ft (Figures 3a and b). If the co-located couplets do not agree with each other, the SU configuration will be changed to enlarge the area covered and the increase the number of increments until couplets do agree. Once the appropriate SU configuration is established, singlet SUs will be used, although occasional couplets may be used as QC or to verify critical decision points, as indicated by the conditions encountered in the field.

Lead data will be generated from the field samples using a XRF. Within-sample heterogeneity will be controlled through a combination of sample processing and replicate XRF readings so the true sample concentration will be determined. Sample processing prior to XRF analysis will take exposure and transport mechanisms into account by evaluating the relationship between soil particle size and Pb concentration. Rapid turnaround of sample concentrations will enable the project team to make real-time decisions that perfect the SU configuration, and that locate the near-surface and at-depth 200-ppm boundaries in the most efficient means possible.

The SU strategy will be used to sample transects spoking from the known source area. SU data will be evaluated using geostatistical modeling (Surfer) and professional judgment to identify a tentative 200-ppm boundary. A DU strategy (larger, band-shaped areas sampled with 30 increments) will be used to confirm the 200-ppm boundary to complete the field investigation.

SU sampling will involve two types of soil sampling tools. Initial field work, especially that involved with perfecting the SU configuration, will rely mostly on a CMIST sampler (Figure 2d), with a 4-cm diameter/3-inch depth cup. Later in the project, a 2-ft./1-inch diameter probe will be used to collect soil

samples (Figures 2a, b and c). The exact mechanisms used to deploy the probe will depend on the relative difficulty encountered when probing the subsurface.

Figure 2: Sampling Devices

Soil Probe and Drive Mechanisms: a.) Hand driven slam bar/slide hammer, b.) electric hammer drill, c.) small GeoProbe rig, d.) CMIST Sampler

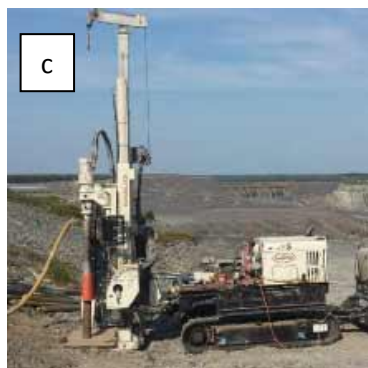
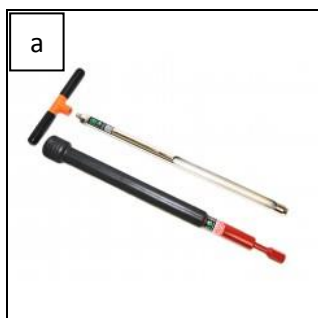


Figure 3: Sample Strategies and Designs

Figure 3a - Screening samples at potential source area collected using a nine-point increment

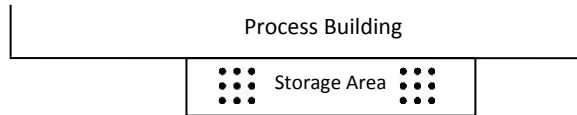


Figure 3b – Traverse using series of nine-point incremental samples away from the source

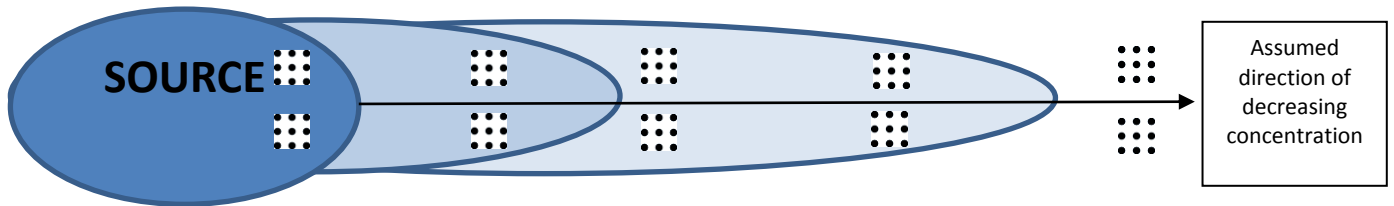
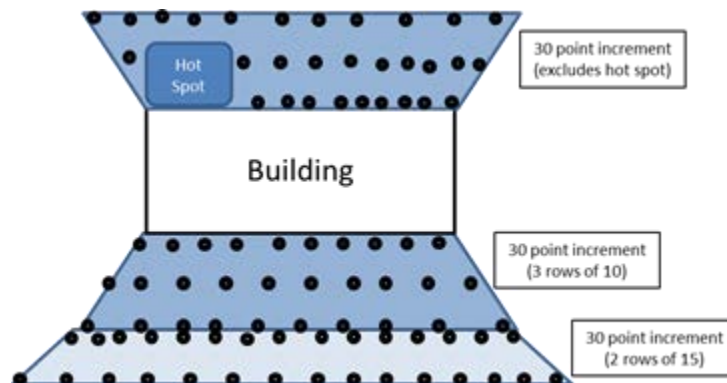


Figure 3c - Decision Units using a 30 point incremental sample.



If an elevated concentration of lead is found in a potential source area (PSA), the extent of lead above the screening level will then be delineated. Assuming that the lead concentration decreases with distance from the source, a series of nine-point samples will be collected along a linear path (a transect) (Figure 3b). This screening strategy will be used to identify the 200 mg/kg boundary. A series of transects radiating from the source area may need to be performed to develop the boundary line and define an area.

After identifying the boundary of the contaminated area with screening sample traverses, incremental composite samples will be collected over a larger area to confirm the concentration is either greater or less than the screening level. These DUs are generally less than 6,000 square feet. A 30-increment composite sample will be collected across the DU to characterize the overall concentration of the DU.

Only 30 increment samples collected across a DU will be used to delineate the screening level boundary. DUs may represent either ecological exposure units (0 to 6 inches), or human health exposure units (6 to 24 inches) (Figure 3c). It is possible that the DU for the 0 to 6 inch interval will be different from the 6 to 24 inch interval. The size of a DU will be selected to reflect the resolution required for the decision, and the physical characteristics of the area.

The description above represents a generalized approach for the sampling program. This Work Plan follows a Systematic Project Planning approach and uses a dynamic work strategy that allows for field-based decision making based on results from the near real-time XRF analysis. Site conditions and real time results may require modification or expansion of the strategies to optimize the sampling program and provide additional data for post-investigation decision making. Additionally, the two AOCs have different physical features and reflect different source and migration mechanisms and will necessarily require different strategies in the field. The specific approaches for sampling at each AOC are described in Sections 2 and 3 of this Work Plan.

1.4. Work Plan Organization

This Work Plan includes two components, the Sampling and Analysis Plan and the Quality Assurance Project Plan (QAPP), and is organized in five sections.

- **Section 1** is an introduction to the site and the general methods that will be employed during the investigation. It describes the basis and theory of incremental composite sampling, and a general description the sample designs that will be used during the investigation.
- **Section 2** is the Sampling and Analysis Plan for the Lead Sweetening Area (LSA) and presents a description of the sampling strategy, sample design and decision logic for the investigation.
- **Section 3** is the Sampling and Analysis Plan for the Ethyl Blending Area (EBA) and provides a description of the sampling strategy, sample design and decision logic for the investigation.
- **Section 4** is the QAPP which follows the format of the Uniform Federal Policy Quality Assurance Project Plan.
- **Section 5** provides references cited in this Work Plan.

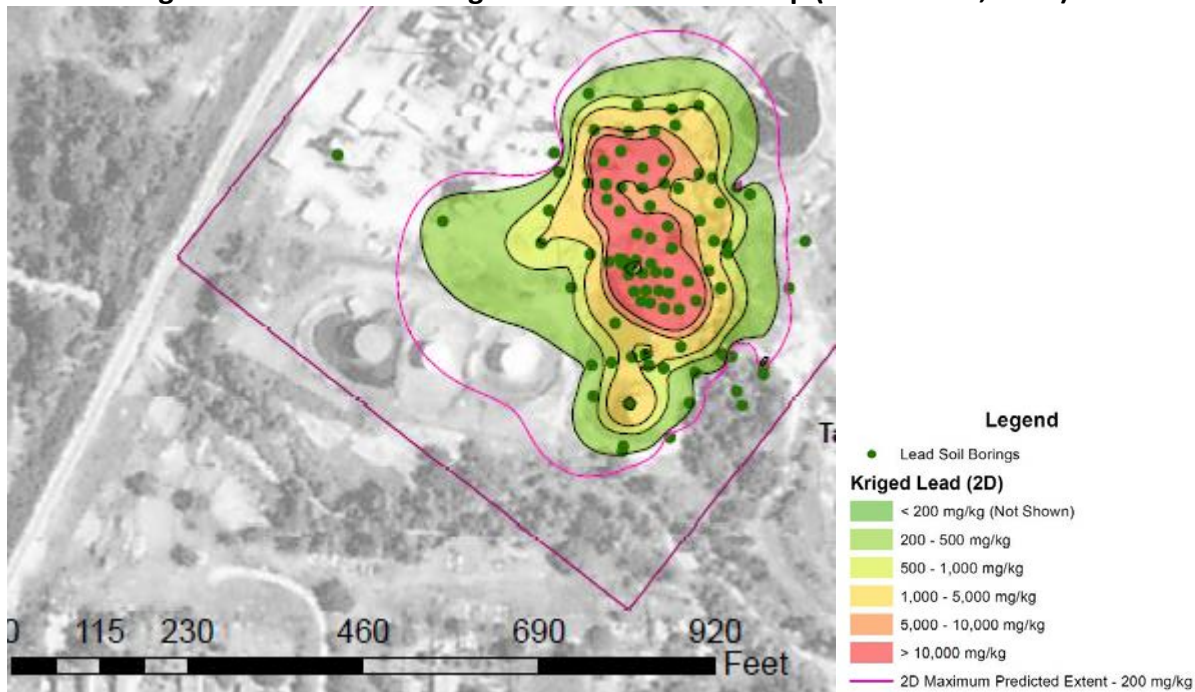
2. Sampling Design and Strategy for the Lead Sweetening Area

2.1. Source Area Description

The Lead Sweetening Area (LSA) is located in the south-central portion of the Wilcox property just north of Tank 34. Historical maps indicate the area contained acid tanks, agitators, treaters, nearby “run down” tanks, and condensate tanks. The area is very sandy with minimal plant growth and contains areas of sparkling sands/salts. Erosion is noted from this area to the south toward Sand Creek, and the tributary to Sand Creek to the east.

The SERAS report (Lockheed Martin, 2016) states that the doctor sweetening process was used in this area and included sodium plumbite (Na_2PbO_2), sodium hydroxide (NaOH), and elemental sulfur or sulfonic acid to produce lead sulfide precipitate. The SERAS investigation identified phenolic compounds in the subsurface soils which were associated with the process. Crystals were observed on the surface in this area and XRF analysis showed that they contained very high lead content (percent levels above the calibration range). Vertical contamination of lead was investigated at five boring locations. In four of the locations, lead was found above 200 mg/kg in the upper foot of soil only, and at the remaining location it was detected at a maximum depth of 4 feet. Groundwater samples from the area show elevated lead concentrations (up to 151,000 mg/L - near Tank 34), and are believed to reflect perched water zones.

Interpretation of the XRF data produced a contour map of lead concentration (Figure 4). The estimated area of concentration greater than 200 mg/kg is approximately 6 acres (600 feet north-south and 500 feet east-west) and the high concentration area, greater than 10,000 mg/kg, is approximately 0.6 acres (approximately 250 feet north-south and 100 feet east-west). Most of the soil sample lead measurements were taken with a handheld XRF at the ground surface, and there is limited data regarding the vertical extent of lead contamination. The subsurface sample near the center of the area analyzed showed high concentrations (greater than 5,000 mg/kg at a depth of 1 foot).

Figure 4: Lead Sweetening Area Lead Contour Map (from SERAS, 2016)

The soil concentrations of lead in the LSA are very high and worker safety will be the highest priority when sampling and handling these samples. Details of the health and safety requirements are provided in the Site Health and Safety Plan.

2.2. Sampling Design

The sampling design presented below is based on the preliminary information and XRF data contained in the SERAS report. The Conceptual Site Model (CSM) presented below reflects interpretation of preliminary sampling with handheld XRF and general observations of site conditions. This approach assumes, based on kriged and contoured data, that the LSA contains a high lead concentration source in the middle, and concentrations decrease away from the source. An estimate of the 200 mg/kg delineation line based on the ERT XRF data is very rough, but can serve as a starting point for the additional delineation under this current investigation. This investigation will evaluate the concentration of lead in the two potential exposure zones in upper two feet of soil (0 to 6 inches and 6 to 24 inches).

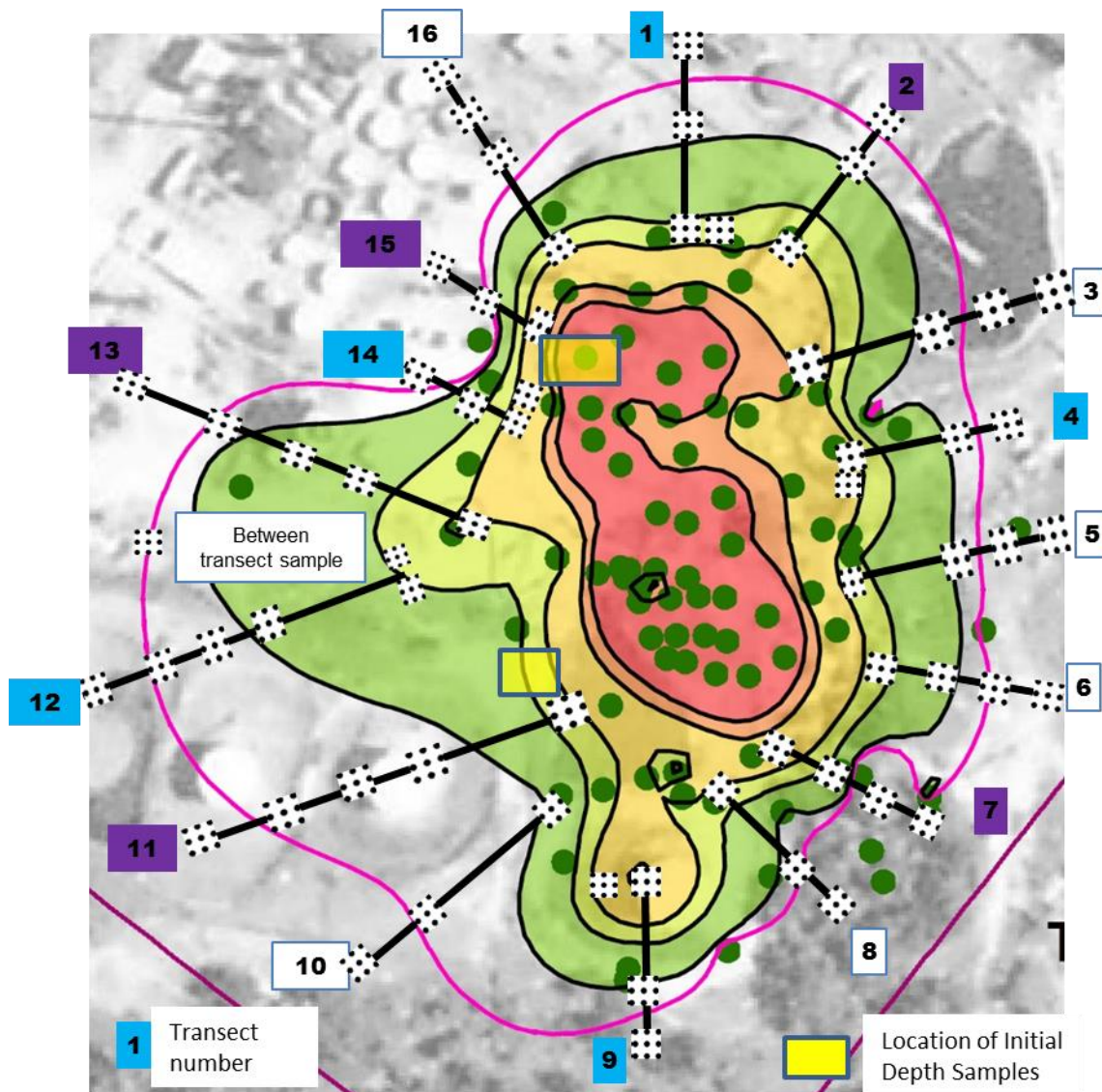
The general approach will be to determine the lateral extent and if the lead is likely to have migrated vertically to the deeper soil (6 to 24 inch zone). The horizontal 200 mg/kg boundary will be located using SU composite samples along radial transects. Once the boundary is located, DUs will be established to confirm the concentrations on the less than 200 mg/kg side of the boundary. Quality control procedures will be implemented to evaluate SU precision during the investigation, and refine the SU configuration (the area covered by the SU and the number of increments per SU) as necessary. The details of the approach are presented below.

The starting point for the delineation will be near the center of the high concentration area to determine the extent of horizontal and vertical (up to 2 feet) lead migration. Understanding the

migration pattern will assist in developing the subsequent sampling locations and determine the approach for collecting subsurface samples at each location. SU samples will be collected from soil cores at 0 to 24 inches in two areas adjacent to the highest concentration areas (yellow boxes on Figure 5). SU samples will initially consist of nine- increment composite samples collected in a 2 foot by 2 foot area. The selected sample locations provide depth information from the putative high concentration area, which appears to be elongated in a north to south direction (shown in Figure 4). The most northerly sample will be collected near the ERT location of WIL-AA-10, where previous samples showed concentrations of 929 mg/kg at 2 feet and 609 mg/kg at 4 feet. Cores will be split into 0 to 6 inch and 6 to 24 inch intervals, and the depth-specific core segments composited together so that each interval is analyzed separately. If lead concentrations greater than 200 mg/kg are found in the 6 to 24 inch intervals samples, the sampling strategy will continue with investigations to address the 6 to 24 inch interval as described in Section 2.2.2.

2.2.1. Surface soils (0 to 6 inches)

Delineation of the 200 mg/kg boundary line will use surface SU samples along 16 radial transects that cross the interpreted 200 mg/kg line developed from SERAS XRF data (Figure 5). SU sampling along the transects will begin at inner locations closest to the source area and will extend outward past the interpreted 200 mg/kg line. The proposed locations may be altered to address site conditions and avoid obstacles. The initial evaluation will be conducted using the CMIST sampler which obtains soil volume from the 0 to 3 inch interval.

Figure 5: Proposed Screening Transects at the Lead Sweetening Area

Approximately 500 feet

Initially two SU samples (SU couplets), five feet apart, will be used as quality assurance to test the reliability of an SU sample result. SU couplets will be taken at the first sampling point on transects 1,4,9,12 and 14 to evaluate precision related to contaminant heterogeneity in the soil. If poor precision is observed in this initial 5-couplet data set, the SU configuration will be changed. Unless contra-indicated by conditions on the ground, the second SU configuration to be tested will cover a 3 x 3 sq.ft. area with 12 increments. The precision of the new configuration will be tested with the SU couplets collected at the inner locations of transects 2,7,11,13 and 15. If the couplet precision in this second 5-couplet set is also poor, the number of increments will be increased. If a satisfactory SU configuration cannot be found, potentially all SU samples will need to be collected as couplets to control decision error. When a satisfactory SU configuration is found, subsequent SUs will be collected as singlets using

that configuration. The data from both sets of inner transect samples (1,4,9,12,14, and 2,7,11,13,15) will be compared to the diagram of the SERAS kriged in-situ XRF data. If the SU concentration data generally agrees with the SERAS kriged concentration data, then the remaining inner transect ends (3, 5, 6, 8, 10 and 16) do not need to be collected because it is assumed they will be significantly greater than 200 mg/kg. If the SU data do not agree with the SERAS model, the remaining six inner transect samples will be collected and analyzed.

It is most likely that the inner SU samples at each transect will show a concentration greater than 200 mg/kg. If that is not the case, the next SU location will be moved closer to the source area along its transect. If the first SU of a transect does have a concentration greater than 200 mg/kg Pb, the next SU sample will be collected approximately 100 feet further out (i.e., away from the source) along the transect. For most of the transects, it is anticipated that the second SU sample will be located just beyond the interpreted 200 mg/kg line of the SERAS model. If the first SU sample shows a concentration less than 400 mg/kg, the second SU may be located at a lesser distance out, such as 50 feet, rather than 100 ft.

For each transect, the 100-foot step-out SU sample result will be evaluated to determine if additional step-out SUs are needed according to the following criteria:

- If the XRF lead result at the 100-foot SU is greater than 250 mg/kg, then a new SU is placed 50 feet further away from the 100-foot location along the transect. This process will be repeated until the next screening criteria below are met.
- If the XRF lead result at the 100-foot SU (or a subsequent step-out SU) is less than 250 mg/kg, a tentative 200 mg/kg boundary line that represents the 0 to 3 inch interval will be established at that location. This point will be added to the site map, and the location will be marked in the field. Additional SUs may be located between transects along the tentative perimeter to refine the line location as indicated by elevated uncertainty in the geostatistical modeling and/or professional judgement.

The 200 mg/kg line for 0 to 3 inch screening samples will be generated using geostatistical modeling to produce a contour map. At this point in time, the field effort should have produced the following:

- A reliable SU configuration so that subsurface sampling can rely on singlet SUs.
- A tentative 200-ppm boundary for the 0-3 inch interval, unless it is discovered that surface concentrations never fall below 200 ppm in this general area. If it appears that a reasonable 200-ppm boundary cannot be located, the field team will consult with the Site's RPM to determine a future direction.
- Possible identification of visual cues (color, crystals, etc.) denoting high lead concentrations such that actual sample analysis is not needed to determine whether the Pb concentration is greater than 200 mg/kg.

Subsequent SU samples will be taken using a 2-ft. probe. The 0 to 6 inch core segment from all the probe locations described below will be archived for possible future analysis. The 6-24 inch interval will be processed and analyzed as discussed below.

2.2.2. Subsurface soils (6 to 24 inches)

Using the information obtained from the two depth SUs (yellow boxes) collected from within the source area (as shown in the SERAS model) and information learned from the 0-3 inch sampling effort, selected inner transect depth SUs will be placed near the furthest inward (presumed highest) location along transects 1,4,9,12 and 14 using the proven SU configuration from earlier steps. Samples will be evaluated for visual cues for high levels of lead contamination in the subsurface (crystals or discoloration). If all of the inner transect samples and the two high concentration area samples do not show greater than 200 mg/kg lead concentration in the 6 to 24 inch interval or other visual evidence of lead contamination, then no further evaluation is needed for the 6-24 inch interval and the subsurface investigation is completed.

If these initial subsurface samples show evidence of contamination or concentrations greater than 200 mg/kg, delineation of the subsurface soils will continue as described below using single SUs and the 1 inch diameter, 24 inch long soil probe.

The 200 mg/kg perimeter developed from the 0 to 3 inch SU samples and geostatistical modeling will be used as a starting point to evaluate the extent of the subsurface contamination. These depth samples will be used to determine whether contamination greater than 200 mg/kg might exist in the 6-24 inch depth interval at this outer perimeter. If no contamination greater than 200 mg/kg is found at depth along the surface perimeter, sufficient depth SUs will be placed inside the perimeter to allow kriging of the 200-ppm boundary at depth. Iterative evaluation of the kriged boundary for excessive uncertainty will trigger iterative placement of depth SUs to firm up the 200-ppm boundary at depth.

Samples will be collected from the appropriate number of transects at the 6 to 24 inch interval. The 0 to 6 inch interval for each of the samples will be archived and the 6 to 24 inch interval will be analyzed for lead with XRF. If visual indications of source material are identified, then the sample will be assumed to exceed the criteria and will not be analyzed with XRF. The results will be used as input to the geostatistical modeling to estimate the 200 mg/kg boundary.

Additional SUs will be placed, if necessary, along or between transects to refine the location of the subsurface 200 mg/kg line. The need for, and location of additional samples will be informed by geostatistical modeling and professional judgement. At this point, a 200-ppm boundary for the 6-24 inch interval has been established using SUs and kriging. This subsurface boundary will have sufficient conservatism to serve as an excavation boundary at depth. (Confirmation of the boundaries can be provided at the time of excavation by real-time incremental sampling and XRF analysis of the excavation's side-walls and floor). Development of a 200-ppm boundary specifically for the 0-6 inch interval will depend on the relative size of the 6-24 inch area to the bounded 0-3 inch area. Theoretically, the boundary for the 0-6 inch interval will lie within the boundary of the 0-3 inch area. Also, any soil found to have a concentration greater than 400 mg/kg in the 0-3 inch depth must necessarily have a concentration greater than 200 ppm for the 0-6 inch interval. If the difference in sizes between the 6-24 depth boundary and the 0-3 inch boundary is minor, or if the difference in size

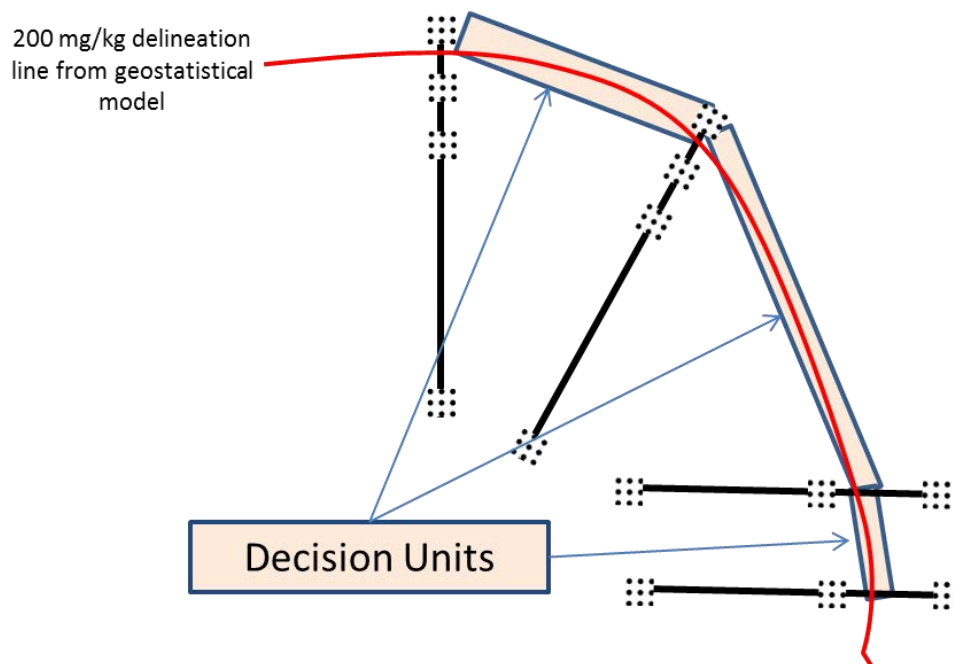
between the 200-ppm and 400-ppm modeled boundaries for 0-3 inches is minor, active sampling to delineate the 0-6 inch boundary as distinct from the 0-3 inch boundary may not be necessary or cost-effective. But if active delineation of the 0-6 interval is desirable, selected archived samples will be retrieved for processing and analysis, and the data kriged. If necessary, additional 0-6 inch cores can be collected and analyzed to reduce boundary uncertainty in specific locations.

2.2.3. Confirming the delineation with Decision Units

Using the interpreted boundary line, DUs will be developed on the outer (lower concentration) side of the 200-ppm surface boundary to confirm the accuracy of the boundary using DUs and 30-increment samples. Each DU will be approximately 20 feet wide and 100 to 300 feet long (Figure 6). Two-foot cores will be used to collect the increments, which will be split into the 0-6 inch and 6-24 inch intervals. The 0-6 inch interval will be processed and analyzed. Because the excavation boundary for the 6-24-inch interval was already established with SUs and the accuracy of that boundary can be established at the time of excavation. The 6-24 inch interval DU samples will be archived, and analyzed only if a reason to do so arises.

The corners of each DU at the transects will be flagged and a 30 increment sample will be collected at each DU using the 24 inch core sampler. Approximately 8 to 16 DUs will define the 200 mg/kg line for each depth interval.

Figure 6: Example Decision Units for confirmation of area less than 200 mg/kg



2.3. Decision Logic

The decision logic for the LSA is presented in Figure XX.

Decision diagram/flow chart is under development.

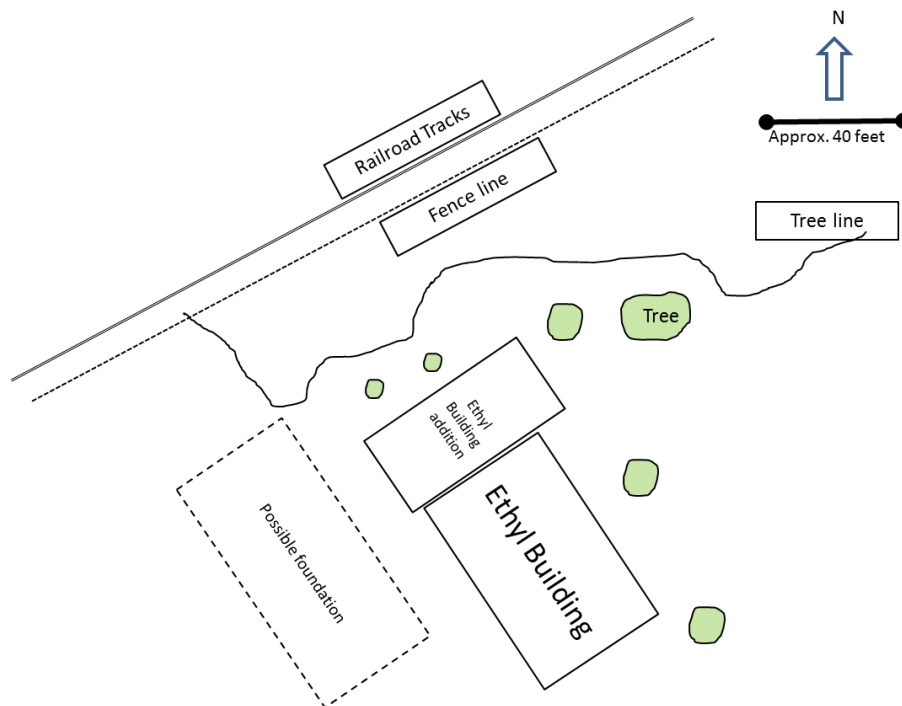
3. Sampling Design and Strategy for the Ethyl Blending Area

3.1. Source Area Description

The Ethyl Blending Area (EBA) is located in the Upper Wilcox Process Area in the northwest corner of the Wilcox Refinery (Figure 1). The area contains an intact main building measuring approximately 45 by 40 feet, with a sign reading “Ethyl Blending” and was presumably used to blend liquid tetraethyl lead (TEL) into the final gasoline product. TEL, which was TEL blended with the lead scavengers 1,2-dibromoethane and 1,2-dichloroethane, is normally supplied as ethyl fluid and contained a reddish dye to distinguish treated from untreated gasoline. Historical maps and photographs show no other permanent buildings within approximately 100 feet, but a rectangular feature (possible fence, slab or foundation) appears to be present on the southwest side of the building. Recent aerial photographs indicate the area is relatively flat and currently contains several large trees.

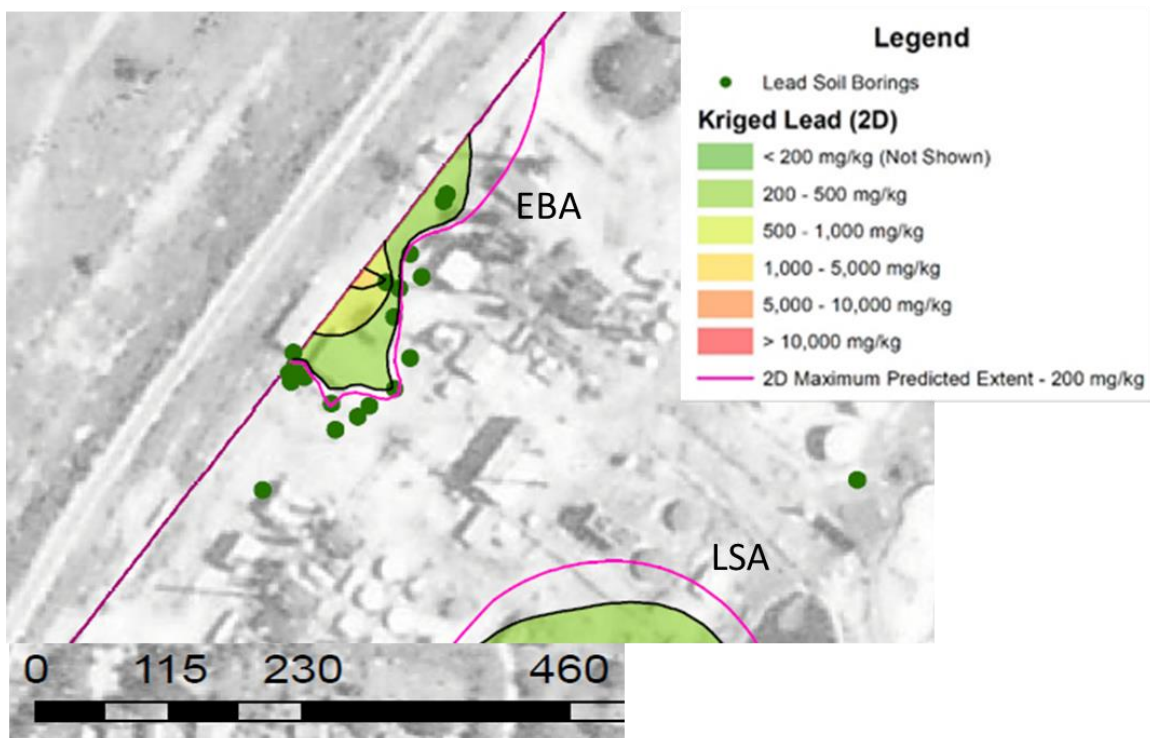
Historical aerial photographs show that between 1941 and 1956 the building was expanded to the northwest and the addition appears to have a lower roofline possibly indicating a storage area approximately 20 by 50 feet. Lighter colored ground on the southeast side of the building indicates surface disturbance. Access to the building includes a road parallel to the railroad and fence line that terminates at the northwest side (rear) of the building, and a larger road to the east that services several buildings in the area. A line drawing of the EBA AOC, developed from a recent aerial photo is shown in Figure 7.

Figure 7: Ethyl Blending Area



The SERAS investigation included screening surface soils with XRF at approximately 25 locations in the EBA. There is limited discussion of the EBA results in the SERAS report, but a contour map of lead concentration was prepared and is shown in Figure 8. The map shows an area of lead contamination above the 200 mg/kg screening level near the building, increasing in concentration westward towards the railroad and Lorraine area. The area greater than 200 mg/kg extends less than 100 feet to the east, but appears to be elongated several hundred feet in the north-south direction. Most readings were between 100 and 600 mg/kg. The maximum concentration is 1,449 mg/kg.

Figure 8: Ethyl Blending Area Lead Contour Map (from SERAS, 2016)



3.2. Sampling Design

The sampling design reflects an early CSM based on the limited knowledge and data regarding the history, source and existing conditions at this AOC. This approach assumes that the building, and its immediate proximity is the most likely source area, and concentrations decrease away from the source. However, we recognize that the SERAS contour map suggests a contamination pattern that increases away from the rear of the building (to the northwest).

The sampling strategy for delineating the 200 mg/kg area will begin with a visual evaluation of the existing conditions to identify any PSA such as material storage areas, product transfer points, release areas adjacent to doors, and any stained or distressed areas near the building. If such areas are identified, a sampling program will begin on each side of the building where a PSA is located. Surface soils in the PSA will be evaluated using screening samples to determine if concentrations are greater than the screening level. One or more nine-point screening samples will be placed in each PSA. If the PSA exhibits high concentrations (greater than 1,000 mg/kg) it will be considered a hot spot area. Two

additional screening samples will be collected on that side of the building to characterize the concentration of the area in order to assess the area of the hot spot and develop a DU for definitive sampling. Hot spot areas will not be included in the DU.

If surface contamination on any side of the building is found above the screening level and below 1,000 mg/kg, a DU will be developed to characterize the area for both surface and subsurface intervals on that side of the building (Figure 9). The size of the DU will be selected to represent an area with similar physical characteristics and small enough to represent a similar set of contaminant conditions. The area of the hotspot (if present) will not be included in the DU (top of Figure 3c). If surface concentrations are below the screening level a decision unit will be developed to characterize the area and a 30 point sample will be collected. All PSAs identified in the visual evaluation will be sampled in this manner, and each side of the building will be evaluated.

If no PSAs are identified in the visual evaluation, two nine-point samples will be collected along each side of the building to determine the PSAs and the decision logic below will be followed for selecting the subsequent sampling locations and DUs to delineate the 200 mg/kg area. The locations of the nine point samples will be described in the QAPP.

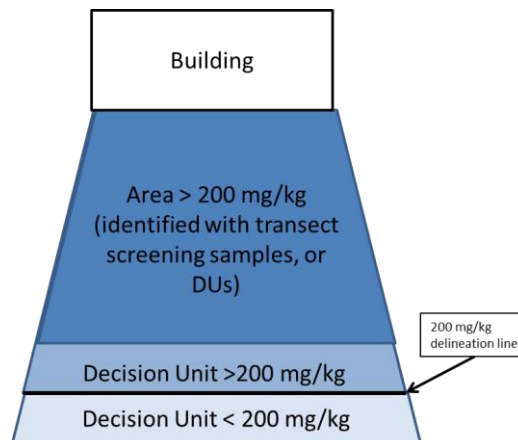
If concentrations greater than the screening level are found at either the surface or subsurface intervals, investigation will proceed in a direction away from the building to evaluate the concentrations further from the source. The magnitude of the exceedance will determine the sampling strategy for step-out locations, as described below.

If the PSA results are between 200 mg/kg and 1,000 mg/kg, DUs will be developed to characterize the area for the surface and subsurface intervals. Samples within this range of concentrations are somewhat greater than the screening level but may indicate the extent of contamination is nearby. The size of the DU will be selected to represent an area with similar physical characteristics and facilitate decision making to optimize the possible removal of contaminated material only. Generally, the DUs will be between 400 square feet and 1,000 square feet in size. The DU will be sampled using a 30 increment sample. If the results of this DU exceed the screening level another DU will be developed further downgradient (approximately 10 feet wide) to determine the extent of the area that exceeds the screening level. Additional DUs will be developed until a DU with less than 200 mg/kg is identified and the 200 mg/kg boundary can be confidently established. The delineation for one side of the building will be considered completed when the results of a DU are less than the screening level. Two DUs, one on each side of the interpreted 200 mg/kg line, are required to confidently establish the area of contamination greater than 200 mg/kg. Figure 9 illustrates the development of DUs to establish the boundary line.

If the PSA results show greater than 1,000 mg/kg additional screening samples will be collected along a transect (a step-out transect) line extending away from the building (Figure 3b). Samples exhibiting concentrations greater than 1,000 mg/kg indicate the source is relatively strong and the area where concentration is less than 200 mg/kg may not be nearby so a DU is not necessary to confidently determine if concentrations are below the screening level. Two screening samples (nine-point) will be collected at each interval (tier) along the transect line, approximately every 10 feet depending on the magnitude of the PSA concentration and physical characteristics. For efficiency, the field team may

collect two tiers of samples at a time. Samples will be collected from the 0 to 6 inch and 6 to 24 inch depth intervals, as necessary. The location where the concentration of the screening sample is below 200 mg/kg will be used to develop a boundary line for a DU to confirm the concentration over a larger area. Two DUs, one on each side of the interpreted 200 mg/kg line, will be developed and sampled to confidently establish the area of contamination greater than 200 mg/kg. Once the two DUs have been confirmed (one above and one below the 200 mg/kg screening value) the delineation on that side of the building will be considered complete. An example of the strategy for transects and confirmatory DUs is shown in Figure 9.

Figure 9: Step out Decision Units for Confirmation



All sampling will be conducted in areas outside the building. No indoor or sub-slab sampling will be performed.

3.3. Decision Logic

The decision logic for the EBA is presented in Figure XX.

Decision diagram/flow chart is under development

4. Quality Assurance Project Plan

4.1. Introduction

This Quality Assurance Project Plan (QAPP) was prepared by the Technology Integration and Information Branch (TIIB) in the Office of Superfund Remediation and Technology Innovation (OSRTI) in support of the United States Environmental Protection Agency (US EPA) Region 6 for performance of a Remedial Investigation to determine the nature and extent of lead (Pb) at two areas of concern within the Wilcox Oil Superfund area. Soils will be assessed for the potential presence and concentration of lead related to historical releases related to storage, use and disposal.

4.2. Uniform Federal Policy Quality Assurance Project Plan

The Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) was developed as a joint initiative between the U.S. Environmental Protection Agency (EPA), the Department of Defense (DoD), and the Department of Energy (DOE) to provide a single format for consistently and systematically implementing the project-specific requirements of ANSI/ASQ E4 across the Federal agencies. It is consistent with EPA's existing QAPP guidance (QA/G-5) and QAPP requirements (QA/R-5). More information on the development and implementation of the UFP-QAPP can be found in the User Manual [ADD REF here](#).

The UFP-QAPP comprises a series of worksheets that contain all the elements of the Quality Assurance plan. The plan is provided in its entirety beginning on the following page.

INSERT COMPLETED QAPP WORKSHEETS WHEN AVAILABLE.

5. References

EA Engineering, Science, and Technology, Inc., PBC (EA). 2016. Draft Sampling and Analysis Plan for Remedial Investigation and Feasibility Study for Wilcox Oil Company Superfund Site, Bristow, Creek County, Oklahoma. April

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